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Herbal Extracts Exhibit Anti-Epilepsy Properties

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Abstract
Epilepsy refers to a group of persistent neurological illnesses characterized by seizures. It is a chronic brain disease that affects 50 million people in the world, being one of the most common neurological disorders. Developing countries account for over 90% of all epilepsy patients. Epileptic seizures are caused by aberrant, excessive, or hyper synchronized neuronal activity in the brain. The cause of most epileptic seizures is unknown. However, some people develop epilepsy as a result of a brain injury, stroke, brain tumor, or drug and alcohol abuse. Anti-seizure drugs remain the mainstay in the treatment of epilepsy and about 70% of epileptics become seizure-free when antiseizure medications are taken effectively. However, some of these medications have significant pharmacological interactions and undesirable side effects. Traditional utilization of plants extracts for treatment of epilepsy is widely practiced. Many plants extracts and herbal formulations have been studied to determine their efficacy in treatment of epilepsy. This paper presents a review on herbal extracts that have shown antiepileptic activity in animal models published in the last ten years (between 2014 and 2024). The study found that plant extracts from some 138 plant species belonging to 54 different plant families were evaluated for antiepileptic efficacy. The most studied plants belong to the Asteraceae family (19%) followed by Fabaceae (9%), Apiaceae (8%), Lamiaceae (8%), Apocynaceae (7%), Cucurbitaceae (3%), Euphorbiaceae (3%) and Rutaceae (3%). In most cases, the studies focused only on the crude extracts without any attempts to identify the antiepileptic compounds from the plants. The most commonly used model in the antiepileptic assays were found to be pentylenetetrazole and maximal electroshock models. The findings from this study confirm that plant extracts have significant efficacy that needs to be explored for antiepileptic formulation and drugs development. It is also necessary to perform bioassay guided phytochemical evaluation to isolate and characterize the antiepileptic principles.

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I. Introduction

Medicinal plants play an important role in healthcare due to their abundance of bioactive chemicals with therapeutic potential [1-3]. A large proportion of population in developing countries still depend on herbal medicine for their basic medical care [4-8]. Plant-produced secondary metabolites have anti-disease characteristics for a variety of illnesses [9-13]. Traditional remedies are favored because of their accessibility, effectiveness, affordability and lack of adverse effects to the user and environment [14-17]. Additionally, there is little likelihood of acquiring medication resistance. Currently, different medicinal plants are being investigated through *in-vivo* and *in-vitro* trials to ascertain claims on their therapeutic properties [18-22]. Previous phytochemical analysis of bioactive extracts from plants have led to discovery of a number of important bioactive drugs including terpenoids, alkaloids, steroids, flavonoids and quinones [23-28]. A number of secondary metabolites derived from plants that had not previously been known to have pharmacological activities are being studied as a source of medicinal agents [29-33]. Such bioactive compounds are a major source of lead compounds that are useful in new drug discovery and drug development [34-44].

Epilepsy is a long-term condition that significantly impairs the central nervous system. Depending on the specific brain region involved, it causes aberrant brain functioning that lead to epileptic seizures and related behavioral abnormalities. These behavioral illnesses might be classified as anxiety, depression, or memory impairment [45, 46]. Epilepsy can arise from endemic risk factors such as neurocysticercosis, road traffic accidents, malaria, and trauma connected to childbirth [47, 46]. Epilepsy impairs the quality of life for over 13 million people, cause over 125,000 deaths, and result in five million new instances of the illness each year [48]. At any given time, 4 to 10 out of every 1000 persons with epilepsy require therapy. Estimates of the number of new cases of epilepsy in high-income and low-income nations are 49 and 139 instances per 100,000, respectively. Eighty percent of epileptic patients live in low- and middle-income nations [48]. Anti-seizure drugs remain the mainstay in the treatment of epilepsy and about 70% of epileptics become seizure-free when antiseizure medications are taken effectively [49]. However, these medications have significant pharmacological interactions and undesirable side effects. About half of patients receiving treatment with contemporary pharmaceuticals still have seizures,

even with the wide range of antiepileptic medications available [49]. In low- and middle-income nations, a sizable portion of epilepsy patients do not obtain treatment because of poverty and poor medical structures [50].

Traditional utilization of plants extracts for treatment of epilepsy has been widely practiced [51]. Many plants extracts and herbal formulations have been studied to determine their efficacy in treatment of epilepsy and the data is scattered in literature. The Sarangdhar Samhita, an ancient Ayurvedic literature, highlights the use of polyherbalism in the long-term treatment of illnesses [52]. Polyherbal formulations have several bioactive principles that are given by the herbs in small amounts. This allows the formulation to act on a problem through a variety of mechanisms while also having low toxicity and minimal adverse effects [52].

This paper presents a review on herbal extracts that have shown antiepileptic activity in animal models published in the last ten years (between 2014 and 2024).

II. Antiepileptic Plant Extracts

The anticonvulsive activity of an aqueous ethanol extract of a combination of three plant roots namely *Calotropis procera, Combretum micranthum,* and *Ficus abutilifolia* was examined using the maximal electric shock (MES), 4-amino pyridine (4-AMP) and pentylenetetrazole (PTZ) models. The extracts (at different doses) dramatically shortened the animals' mean recovery time and delayed onset of seizures [53]. In maximum electroshock and pentylenetetrazole-induced convulsions in rats, a polyherbal formulation containing *Terminalia chebula, Asparagus racemosus, Embelia ribes, Acorus calamus, Tinospora cordifolia, Convolvulus pluricaulis, Saussurea lappa* and *Achyranthes aspera* was found to be effective in treating epilepsy [54]. In Swiss albino mice, MES and PTZ-induced epileptic seizures were lessened by a polyherbal ethanolic extract including *Zingiber officinale, Caesalpinia bonducella, Aloe vera,* and *Croton figilum* at concentrations of 200 and 400 mg/kg [55].

In maximal electric shock, pentylenetetrazol and isoniazid-induced convulsions, the methanolic extract of a polyherbal formulation containing *Operculina turpethum, Mimosa pudica, Uraria picta, Cajanus cajan* and *Lawsonia inermis* prolonged the onset and reduced the duration of the seizures [56]. In suppressing both MES and PTZ-induced convulsions in Wistar albino rats, a chloroform extract of *Diplocyclos palmatue* leaves, *Abutilon indicum* stem, and *Cassia occidentalis* whole plant formulation demonstrated anticonvulsant activity comparable to phenytoin [57]. In another study, a combination herbal extract of *Brassica nigra* and *Swertia chirata* effectively reduced the onset and duration of seizures in the pentylenetetrazole paradigm in Wistar albino rats [58]. Table 1 gives a summary of some plants that have been evaluated for antiepileptic efficacy.

Table 1: List of some plants with anticonvulsant activity

Plant	Family	Extract/ fraction	Dose mg/kg	Test animal	Experimental model	Activity	Ref
Acalypha fruticosa	Euphorbiaceae	Chloroform extract	30-300	Swiss albino mice	PTZ, MES, INH	Protected mice from convulsions, delayed the latency of convulsions	59
Acalypha indica	Euphobiaceae	Methanolic extract of leaves	200	Sprague dawly rats	$FeCl_3$	Decreased the duration of tonic hind limb extension	60
Acorus calamus	Acoraceae	Methanol leaves extracts	200-400	Albino mice	PTZ, MES	Delayed onset of the seizures and its shortened phase	61
Aegle marmelos	Rutaceae	Aqueous leaves extract	900	Male Swiss albino mice	PTZ	Delayed the onset and reduced the duration of seizures	62
Ageratum conyzoides	Asteraceae	Hydroalcoholic extract	400-800	Male Swiss mice	MES, PTX	Increased seizure threshold and reduced convulsion duration	63
Albizia amara	Fabaceae	Ethanol leaves extract	400	Albino rats	PILO	Increased the time to onset of seizure and decreased the duration of the seizure; reduced the mortality rate	64
Alchornea cordifolia	Euphorbiaceae	Hydroalcoholic leaf extract	200-800	Balb/c mice	PTZ	Delayed onset and duration of seizures	65
Allium cepa	Amaryllidaceae	Methanolic extract	8-16mg/20 g	Male albino mice	MES	Shortened the duration taken for hind limb tonic extension and showed protection	66
Alpinia officinarum	Zingiberaceae,	Hydroalcoholic rhizomes extract	200-600	Male albino mice	PTZ	Prolonged the time of onset of seizure and decreased the duration	67

						of seizures	
Alstonia boonei	Apocynaceae	Methanol stem bark extracts	75-300	Swiss albino mice	PTZ, MES	Increased the onset of seizure and latency to death	68
Anethum graveolens	Apiaceae	Hydroalcoholic leaf extract	250-750	Male BALB/c mice	PTZ	Protective effect against the PTZ-induced apoptotic neurodegeneration.	69
Anethum graveolens	Apiaceae	Hydro-alcoholic seed extract	100-1000	Male albino mice	PTZ	Delayed the initiation time of myoclonic and tonic-clonic seizures	70
Annona muricata	Annonaceae	Seed and stem hydroalcoholic extract	200-800	Balb/c mice	PTZ	Delayed onset and duration of seizures	65
Annona senegalensis	Annonaceae	Whole plant hydroalcoholic extract	200-800	Balb/c mice	PTZ	Delayed onset and duration of seizures	65
Anogeissus latifolia	Combretaceae	Ethanolic stem bark extracts	200-600	Swiss albino mice	PTZ, MES	Protection against seizures in both MES and PTZ-induced convulsion models	52
Anogeissus latifolia	Combretaceae)	Ethanolic stem bark extract	200-600	Swiss albino mice	PTZ, MES	Dose-dependent protection against seizures	52
Aspilia africana	Asteraceae	Ethanol leaf extract	200-25	Male mice	PTZ, MES, STR	Delayed onset of seizure and abolished hind limb tonic extension	71
Asplenium nidus	Polypodiacea e	Methanolic leaf extract	500-1000	Male Swiss mice	PTZ, INH	Decrease the time of onset and duration of convulsion	72
Bauhinia purpurea	Fabaceae	Alcoholic leaf extract	100-400	Wistar albino rats	PTZ, MES	Exhibited anticonvulsant activity against both MES and PTZ induced convulsions	73
Bauhinia purpurea	Fabaceae	Ethanolic leaf extracts	100-400	Wistar albino rats	PTZ, MES	Exhibited anticonvulsant activity against both MES and PTZ models	73
Benincasa hispida	Cucurbitaceae	Fruit juice	900	Male Swiss albino mice	PTZ	Delayed the onset and reduced the duration of seizures	62
Berberis calliobotrys	Berberidaceae	Methanol, ethyl acetate n-butanol extracts	500-1000	Swiss albino mice	PTZ, PTX, STR	Delayed on set of seizures, decreased duration and intensity of seizure	74
Biophytum sensitivum	Oxalidaceae	Ethanolic extract of leaves	50-200	Wistar albino mice	PTZ, MES	Reduced duration of tonic hind limb extension and delayed the onset of tonic-clonic convulsions	75
Biophytum umbraculum	Oxalidaceae	Hydroalcoholic root extract	100-400	Swiss albino mice	PTZ, MES	Enhanced latency time to clonic seizure, mortality prevention	76
Bongardia chrysogonum	Berberidaceae	Ethanolic-aqueous extract	600-1200	Male mice	PTZ	Delayed on set of seizures, decreased duration and intensity of seizure	77
Boswellia dalzielii	Burseraceae	Petroleum ether stem bark extract	20-80	Chick and Albino mice	PTZ, MES, STR, PTX, 4-AMP	Provided protection and increased the mean onset of seizure	78
Brassica nigra	Brassicaceae	Methanolic seed extract	400	Mice	PTZ	Reduced the intensity and duration of seizure	79
Butea monosperma	Fabaceae	Methanol stem extract	100-300	Swiss albino mice	PTZ, MES	Protection against convulsion and mortality; delayed onset of seizure	80
Calotropis procera	Apocynaceae	Hydroethanolic leaf extract	100-300	ICR mice	PTX, STR,	Reduced the duration and frequency of	81

					PILO	convulsions; delayed onset of convulsions	
Carum carvi	Apiaceae	Aqueous extract and essential oil of seeds	200-3200	Male albino mice	PTZ;	Increased latency time to the onset of seizures	82
Celtis integrifolia	Ulmaceae	Methanol leaf extract	200-800	Chick and mice	PTZ, MES, STR, 4-AMP	The onset of seizure and latency to death was increased	83
Cephalaria gigantea	Caprifoliaceae	Root extract	400	Wistar and Krouchinsky - Molodkina rats	PTZ	Seizures onset and duration were reduced	84
Chromolaena odorata	Asteraceae	Ethanol extract of the leaves	50	Swiss Albino Mice	MES	Reduction in the duration of all the phases of epilepsy (Flexion, extensor, convulsion, stupor phases)	85
Chrysanthellum americanum	Asteraceae	Whole plant aqueous extract	27.69-276.9	Male Swiss mice	PILO	Increased the latency convulsions and decreased number and duration of seizures	50
Cicer arietinum	Fabaceae	Dichloromethane extract	400	Mice	PTZ	ED50= 3g/kg; no toxic and lethal effects	86
Cichorium intybus	Asteraceae	Ethanol extract	500	Swiss albino rats	MES, PTZ	Abolition of HLTE rats and prolonged latency to seizure onset	87
Cissus cornifolia	Vitaceae	Methanol leaf extract	75-600	Albino mice	PTZ, MES, PTX, STR, 4-AMP	Prolonged the latency to convulsion	88
Citrullus colocynthis	Cucurbitaceae	Hydroalcoholic fruit extract	10-100	Albino mice	PTZ	Prolonged the onset of seizures and decreased the duration	89
Citrus aurantium	Rutaceae	essential oil	20-40	Male NMRI mice	PTZ, MES	Inhibited convulsion and decreased the mortality rate	90
Citrus sinensis	Rutaceae	Flavonoid-rich extract from orange juice	40	Mice	PTZ	Inhibited tonic seizures and increased latency	91
Combretum hypopilinum	Combretaceae	Methanol leaf extract	150-600	Swiss albino mice	PTZ, MES, PTX, STR	Protection against seizure intensity, latency and lethality	92
Coriandrum sativum	Apiaceae	Hydroalcoholicextract of aerial parts	100-1000	Male Wistar rats	PTZ	Increased the minimal clonic seizures and tonic-clonic seizures latencies	93
Crassula arborescens	Crassulaceae	Le f methanol extract	1,200-4,000	Male albino mice	PTZ, PTX, STR	LD50 value 781.6 mg/kg	94
Crinum jagus	Amaryllidaceae	Methanol bulbs extract	32.50-112.50	Albino mice	MES	Reduced the duration and frequency of convulsions; delayed onset of convulsions	95
Cyperus articulatus	Cyperaceae	Ethanolic rhizomes extracts	50-300	Balb/C albino mice	PTZ	Lowered seizure scores, frequency and duration	96
Decalepis nervosa	Apocynaceae	Aqueous root extracts	250-500	Swiss albino mice	PTZ, INH	anticonvulsant activity	97
Desmodium adescendes	Fabaceae	Whole plant hydroalcoholic extract	500-1000	Balb/c mice	PTZ	Delayed onset and duration of seizures	65
Dorema ammoniacum	Apiaceae	Aqueous gum extract	500-1000	Male albino mice	PTZ	Delayed the onset and the duration of seizures induced	98
Ducrosia anethifolia	Apiaceae	Essential oil	50-200	Male Wistar rats	PTZ	Delayed the initiation time, and reduced the	99

						duration of seizures	
Eclipta alba	Asteraceae	Coumarin fraction	50-100	Male Swiss albino mice	PTZ	Lowered seizure score and delayed the progression of seizure similar to diazepam	100
Elaeagnus angustifolia	Elaeagnaceae	Hydroalcoholic extract	200-400	Male mice	PTZ	Increased the threshold of seizure	101
Emblica officinalis	Phyllanthacea e	Fruit and Leaf extracts	200-600	Mice	STR	Delayed on set of seizures, decreased duration and intensity of seizure	102
Eryngium caucasicum	Apiaceae	Methanolic extracts	250-1000	Male Swiss albino mice	PTZ, MES	Prevented convulsions in mice	103
Feretia apodanthera	Rubiaceae	Aqueouss extract	150-200	Male Swiss mice	PTZ	Increased latency to seizures	104
Ferula assa-foetida	Apiaceae	Oleo gum resin water extract	50-100	Male Wistar rats	PTZ, MES	Prevented seizure	105
Ficus benjamina	Moraceae	Petroleum ether, methanol fig extract	100-400	Swiss albino mice	MES, PTX	Reduced the duration of the tonic hind limb extensor and extensor-to-flexor ratio	106
Ficus sycomorus	Moraceae	Methanol root bark extract	150	Mice and chicks	MES, PTZ, 4-AMP	Protection to test animals	107
Ficus thonningii	Moracea	Leaf & stem bark hydro-alcoholic extracts	200-800	Balb/c mice	PTZ	Delayed onset and duration of seizures	65
Fumaria schleicheri	Papaveraceae	Water extract	100	Albino mice	PTZ	Delayed the onset and reduced the duration of seizures	108
Globimetula braunii	Loranthaceae	Ethyl acetate leaf extract	150	Mice and chicks	MES, PTZ, 4-AMP	protected mice and increased the onset of seizers	109
Gomphrena Serrata	Amaranthacea e	Ethanolic plant extract	600	Swiss albino mice	PTZ, MES	Decreased the recovery time	110
Harungana madagascariensis	Hypericaceae	Aqueous seeds extract	5-20	Swiss albino mice	PTZ, PTX	Protected animals against convulsions	111
Hemidesmus indicus	Apocynaceae	Stem & leaves extracts	200-400	Wistar rats	MES	Delayed onset and reduced duration of seizures	112
Heracleum persicum	Apiaceae	Hydroalcoholic leaf extract	300-600	Wistar rats	PTZ	Reduces the mean survival time in tonic and tonic-clonic seizures	113
Hippocratea africana	Celastraceae	Root extract & fractions	200-600	Swiss albino mice	PTZ,	Delayed onset of convulsions and prolonged the time of death	114
Hippocratea welwitschii	Celastraceae	Hexane, ethyl acetate, methanolic root extracts	125-250	Chicks and Swiss Mice	PTZ, MES, STR	Protected mice against seizure	115
Holoptelea Integrifolia	Ulmaceae	Petroleum ether and methanolic leaves extracts	100-300	Albino mice	PTZ, MES, PILO	Delayed onset of convulsions	116
Indigofera arrecta	Fabaceae	Leaves	400	Zebrafish, male albino Wistar rats	PTZ, MES, PILO	Delayed the onset and reduced the duration of seizures	117
InInula britannica	Asteraceae	Methanol and aqueous root extracts	12.5-800	Male NMRI Albino mice	PTZ, MES	Exhibited anticonvulsant effects	118
InInula helenium	Asteraceae	Methanol and aqueous root extracts	12.5-800	Male NMRI Albino mice	PTZ, MES	Exhibited anticonvulsant effects	118
Inula aucheriana	Asteraceae	Methanol and aqueous root extracts	12.5-800	Male NMRI Albino mice	PTZ, MES	Exhibited anticonvulsant effects	118
Inula oculuschristi	Asteraceae	Methanol and aqueous root extracts	12.5-800	Male NMRI Albino mice	PTZ, MES	Exhibited anticonvulsant effects	118
Inula salicina	Asteraceae	Methanol and	12.5-800	Male NMRI	PTZ,	Exhibited	118

		aqueous root extracts		Albino mice	MES	anticonvulsant effects	
Inula thapsoides	Asteraceae	Methanol and aqueous root extracts	12.5-800	Male NMRI Albino mice	PTZ, MES	Exhibited anticonvulsant effects	118
Inula viscidula	Asteraceae	Methanol and aqueous root extracts	12.5-800	Male NMRI Albino mice	PTZ, MES	Exhibited anticonvulsant effects	118
Ipomea reniformis	Convolvulaceae	Whole plant methanol extract	400	Albino Wister male rats	PTZ, MES, PILO	Decreased severity of seizure grades and reduced mortality rate	119
Ipomoea asarifolia	Convolvulacea	Residual aqueous fraction	75	Swiss albino mice	PTZ, MES	Gave protection against mortality on test animals	120
Juglans regia	Juglandaceae	Methanol extract of kernel	100	Male Wistar rats	PTZ;	Decreased severity of seizures and reduced the mortality rate	121
Kalanchoe pinnata	Crassulaceae	Methanolic root extract and stem extract	100-800	BALB/c mice	PTZ	Increased latency of tonic-clonic seizures	122
Khaya grandifoliola	Meliaceae	Methanol stem bark extracts	75-300	Swiss albino mice	PTZ, MES	Increased the onset of seizure and latency to death	68
Lactuca serriola	Asteraceae	Seed hexane, chloroform, methanol & aqueous extracts	400	Male Swiss albino mice	PTZ	Reduced seizure score	123
Laggera aurita	Asteraceae	Methanol leaf extract	600	Mice, rats, chicks	PTZ, MES, STR, PTX	Protection against tonic hind limb extension: decreased the mean recovery from seizure; increased the mean onset of seizure	124
Lantana camara	Verbenaceae	Stem & Flowers ethanolic & aqueous extracts	200-400	Wistar rats	MES	Delayed the onset and reduced the duration of seizures	112
Launaea acanthodes	Asteraceae	ethanolic extract and aqueous fraction	100-300	Wistar rats	PTZ	Inhibited seizure, delayed periods to the onset of anterior limbs clonus and tonic-clonic attacks	125
Lavandula officinalis	Lamiaceae	Methanolic leaves extract	200-800	NMRI mice	PTZ	Reduced the severity and duration of attacks and eliminated the fifth phase of seizures	126
Lawsonia inermis	Lythraceae	Methanolic leaves extract	200-400	Albino rats	PTZ	Reduced the hind limb tonic extension; reduced duration of convulsions and delayed onset of seizures	127
Leucas martinicensis	Lamiaceae	Ethanolic extract of whole plant	200-400	Swiss albino mice	PTZ	Delayed on set of seizures, decreased duration and intensity of seizure	128
Lophira alata	Ochnaceae	Aqueous extract of stem bark	200-800	LB629 mice	PTZ	Increased onset of tonic-clonic seizures and protection from death	129
Luffa cylindrica	Cucurbitaceae	Alcoholic fruit extract	100-400	Wistar rat	PTZ, MES	Prolonged the latency time and decrease the total time of seizure; decreased the tonic clonic and total seizure time	130
Madhuca longifolia	Sapotaceae	Water wood extract	100-400	Wistar Albino rats	PTZ, MES, PILO	Prevention from seizure	131
Matricaria chamomilla	Asteraceae	Hydroalcoholic extract	800-1000	Mice	PTZ	Delayed onset of seizures reduced mortality rate	70
Matricaria	Asteraceae	Ethyl acetate	25	Mice	STR	Increase in the onset	132

recutita		extract				time and the survival time	
Melanthera scandens	Asteraceae	Leaf aqueous and ethanolic extracts	250-1000	Male Wistar rats	PTZ	Increased seizure latency	133
Mentha piperita	Lamiaceae	Ethanol aerial parts extract	800	White laboratory rats	PTZ	Preventive effects on PTZ-induced epileptic attacks	134
Mimosa pudica	Fabaceae	Petroleum ether leaf extract	100-400	Wistar albino rats	PTZ, MES, INH	Prevented the latency and duration of convulsion	135
Momordica cissoides	Cucurbitaceae	Water leaf extract	42.5-425	Swiss Albino mice	PILO, 4-AMP	Reduced duration and frequency of convulsions; delayed onset of convulsions	136
Musa sapientum	Musaceae	Aqueous stems extract	25-100	Swiss albino mice	PTZ, MES	Increased the latency to onset of convulsions	137
Mussaenda philippica	Rubiaceae	Methanol, dioxin and aqueous extracts	100 & 200	Swiss albino mice	PTZ, MES, STR, PTX	Increased onset of convulsion	138
Nelumbo nucifera	Nelumbonaceae	Fruit extract	50-200	Wister rats	STR	Delayed the inception of convulsions	139
Nigella sativa	Ranunculacea	Hydroalcoholic Seed extract	400-600	Male Swiss albino mice	PTZ, MES	Delayed the onset and reduced the duration of seizures and decreased the mortality rate	140
Ocimum basilicum	Lamiaceae	Methanolic etract	100-350	Female mice	PTZ	Decreased the frequency of epilepsy and mortality	141
Ocimum sanctum	Lamiaceae	Ethanolic leaf extract	1.75-8.5	Albino rats	PTZ, MES	Decreased the duration of tonic hind limb extension	142
Olea europaea	Oleaceae	Hydroalcoholic leaf extract	250-1000	Mice	PTZ	Increased the delay of seizures; reduced the mortality rate	• 43
Peganum harmala	Nitrariaceae	Methanolic extract	45	Wistar rats	STR	Inhibited seizure, decreased the time at onset of seizure and its length, decreased mortality	126
Pergularia daemia	Apocynaceae	Roots	4.9-49	Swiss albino mice	PTZ, PILO	Latency was significantly increased	144
Pergularia daemia	Apocynaceae	Aqueous extract	24.5-49	Swiss albino mice	PTZ	Protected mice seizures; decreased initial and retention transfer latencies in the elevated plus maze	144
Phoenix dactylifera	Arecaceae	Methanol leaf extracts	100-400	Albino Westar rats	PTZ	Protection against convulsion and mortality	145
Phragmanthera austroarabica	Loranthaceae	Methanol extract	800	Male albino mice	PTZ	Reduced final seizure score	146
Pistacia integerrima	Anacardiaceae	Pet-ether and methanolic gall extracts	50-200	Zebrafish, rats	PTZ, MES	Delayed onset of different seizure parameters; delayed duration of hind limb extension	147
Portulaca oleracea	Portulacaceae	Aqueous leaf extracts	200-600	Albino mice	PTZ, MES	Produced anticonvulsant effect against seizures	148
Punica granatum	Lythraceae	Methanolic, leaf extract	50-400	Swiss albino mice	PTZ, MES	Alleviated seizures significantly	149
Rehmannia glutinosa	Scrophulariaceae	Water extract	50-400	Swiss albino mice	PTZ, MES	Increased seizure threshold in mice, decreased the percentage of seizure responses	150
Rosa damascena	Rosaceae	Hydroalcoholic extract	50-200	Male Wistar rats	PTZ	Prolonged the latency of seizure attacks and reduced the frequency and amplitude of epileptiform burst discharges	151

Ruta graveolens	Rutaceae	Hydroalcoholic extract	100-1000	NMRI mice	PTZ	Delayed onset of seizures	152
Salvia sahendica	Lamiaceae	Hydroalcoholic extract	600	Wistar rats	PTZ	Delayed the onset of seizures, reduced the time of seizure and mortality	153
Sambucus nigra	Caprifoliaceae	Methanolic extracts of bark, fruit and leaf	500-1000	Male mice	PTZ, MES	Inhibited convulsion and gave protections against mortality	154
Sapindus emarginatus	Sapindaceae	Methanol leaves extracts	200-400	Albino mice	PTZ, MES	Delayed onset of the seizures and its shortened phase	61
Satureja hortensis	Lamiaceae	Aqueous and ethanolic aerial part extracts	200-600	Male albino mice	PTZ, MES	Increased minimal clonic seizure and generalized tonic–clonic seizures latencies	155
Scrophularia striata	Scrophulariaceae	Hydroalcoholic extract	300-900	Wistar rats	PTZ	Delayed the onset of tonic seizures and reduced the incidence of imbalance and jump	156
Senna spectabilis	Fabaceae	Water extract of leaves	42.6-213	Swiss albino mice	PTZ, MES, PILO	Inhibited tonic seizures and increased latency	157
Silybum marianum	Asteraceae	Seeds ethanol extract	100-300	Wistar rats	PTZ	Provided protection against seizure intensity, latency and lethality	158
Solanum indicum	Solanaceae	Methanol fruits extract	32.5-112.5	Albino mice	MES	Reduced duration and frequency of convulsions; delayed onset of convulsions	95
Syzygium aqueum	Myrtaceae	Methanolic leaves extract	125-500	Albino mice	PTZ, MES	Increased latency of convulsion, reduced seizure duration	159
Tabernaemontana divaricata	Apocynaceae	Aqueous and ethanolic leaves extracts	50-150	Male Swiss albino mice	PTZ, MES	Delayed the onset and reduced the duration of seizures	160
Tanacetum sonbolii	Asteraceae	hydroalcoholic extract	1200	Wistar rats	PTZ	Reduced seizures and delayed onset of seizure	126
Tapinanthus globiferus	Loranthaceae	Butanol fraction	500	Mice and chicks	MES, PTZ	Protection against seizure and prolonged the onset of seizure, decreased the minimum recovery time after hind limb tonic extension	107
Taraxacum serotinum	Asteraceae	Ethanol extract	500	Swiss albino rats	MES, PTZ	Complete abolition of HLTE the rats, prolonged latency to seizure onset	87
Thevetia peruviana	Apocynaceae	Ethanolic leaf extracts	500-750	Wister rats	PTZ	Protected the animals from death and delayed the onset of seizures	161
Thymus vulgaris	Lamiaceae	Water leaf extract	200	Male Wistar Albino rats	PTZ	Protected the animals from death and delayed the onset of seizures	162
Tilia americana	Malvaceae	Leaves and inflorescences methanol extract	600	Female Swiss albino mice	PTZ	Prevented severity of seizures	163
Tragia involucrata	Euphorbiaceae	Methanol leaves extract	400-800	Swiss albino mice	PTZ, MES, PTX	Inhibition on tonic hind limb extension and decrease in duration of stupor period	164
Trichilia roka	Meliaceae	Hydroalcoholic stem bark extract	7.5-30	Swiss albino mice	PTZ, STR, PTX, MES	Prolongation of the mean onset of seizures	165
Trigonella	Fabaceae	Methanol Seeds	200	Albino rats	STR	Increase in the onset	166

foenum-graecum		extract				time and the survival time	
Verbena officinalis	Verbenaceae	Ethanol aerial parts extract	100-400	Male NMRI mice	PTZ, MES	Delayed onset and decreased the duration of the seizures	167
Vitex doniana	Verbenaceae	Stem barks hydroalcoholic extract	200-800	Balb/c mice	PTZ	Delayed onset and duration of seizures	65
Withania somnifera	Solanaceae	Alcoholic extract	100-300	Albino rats	PTZ, MES	Reduction of hindlimb tonic extension and postictal depression; reduced mean duration of hind limb tonic flexion, hind limb tonic extension	168
Xylopia aethiopica	Annonaceae	Methanol fruit extract	75-300	Swiss albino mice	PTZ, MES	Protection against mortality, increased the onset of seizure and latency to death	68
Ziziphora tenuior	Lamiaceae	Hydroalcoholic extract	600-900	Male mice	PTZ	Delayed onset of seizures and decreased the average time seizures	169

MES = Maximal electroshock; PTZ = pentylenetetrazole; 4-AMP = 4-aminopyridine; INH = *Isoniazid*; PILO = pilocarpine; PTX = picrotoxin; STR = Strychnine; MRT = minimum recovery time; NMRI = Naval Medical Research Institute

III. Classification Of Plants Studied

The data retrieved from literature showed that plant extracts from some 138 plant species were subjected assayed to determine their efficacy in the management of epilepsy. The plants belong to 54 different plant families (Figure 1&2). Out of the 138 plant species identified, the most studied one belong to the following families: Asteraceae (19%), Fabaceae (9%), Apiaceae (8%), Lamiaceae (8%), Apocynaceae (7%), Cucurbitaceae (3%), Euphorbiaceae (3%), Rutaceae (3%) and others (40%).

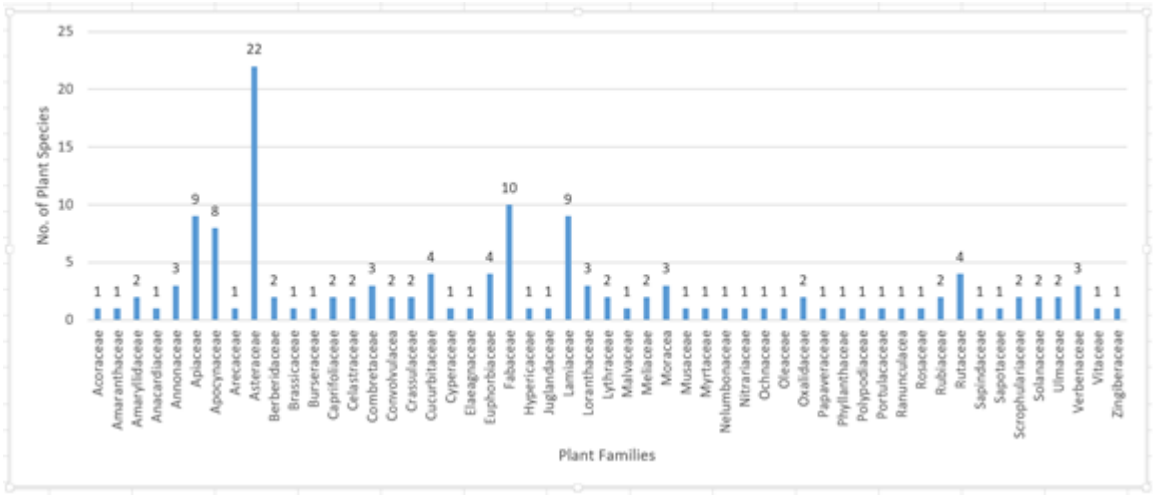

Figure 1: Distribution of some studied plants by plant family

IV. Test Models Used

Pharmacological models in anti-seizure tests are essential for evaluating the efficacy and safety of antiepileptic drugs (AEDs). Table 2 summarizes some commonly used pharmacological models [170]. In these models, researchers typically assess the seizure latency**,** seizure severity**,** duration of seizures and postictal behavior of the test animals. Results from this study indicate that the most commonly used model is PTZ followed by MES (Figure 3).

Table 2: Test models

S/no	Model	Description	Application
1.	Pentylenetetrazol (PTZ) Mode	PTZ is a GABA antagonist that induces generalized seizures	Mice or rats are administered PTZ, and the latency to seizure onset, seizure duration, and severity are measured to assess drug efficacy.
2.	Kainic Acid Model	Kainic acid is a glutamate analog that induces seizures and can lead to status epilepticus.	Administered via injection, it mimics temporal lobe epilepsy. The model allows for the study of chronic seizure activity and neuro-degeneration.
3.	Maximal Electroshock (MES) Model	Involves applying a brief electrical stimulus to induce tonic-clonic seizures.	This model is used to evaluate the effectiveness of drugs against generalized tonic-clonic seizures.
4.	Sodium Channel Blockade Model	Drugs that block sodium channels (like phenytoin and carbamazepine) are tested in models where sodium channel activity is altered.	Helps in understanding the pharmacodynamics of sodium channel blockers in controlling seizures.
5.	Kindling Model	Repeated sub threshold stimulation of specific brain areas leads to progressively increased seizure susceptibility.	Useful for studying the long-term effects of AEDs and understanding the mechanisms of seizure development.
6.	Cortical Spreading Depression Model	Induces a wave of depolarization in the cortex, which can lead to seizure-like activity.	Used to explore the effects of drugs on seizure propagation and cortical excitability.
7.	Chemoconvulsant Models	Models using substances like bicuculline (a GABA antagonist) or 4-aminopyridine (which increases neurotransmitter release).	These models help assess the efficacy of drugs that enhance GABAergic transmission or inhibit excitatory neurotransmission.
8.	Strychnine Model	Strychnine is a glycine receptor antagonist that can induce seizures.	Useful for studying the effects of drugs on inhibitory neurotransmission.

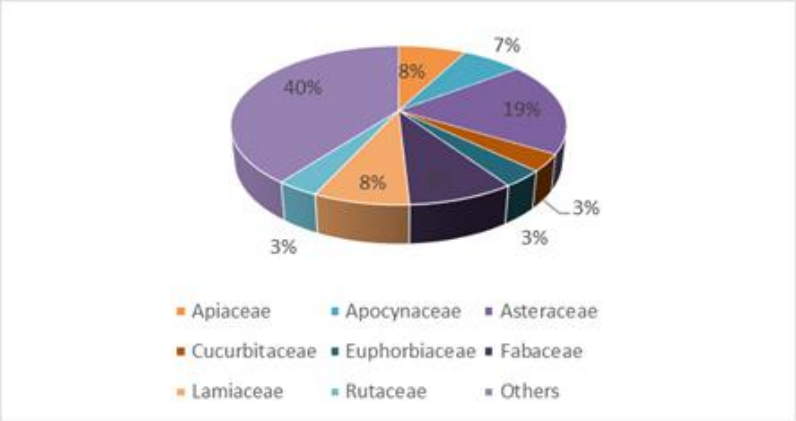

Figure 2: Most studied plant families for antiepileptic activity

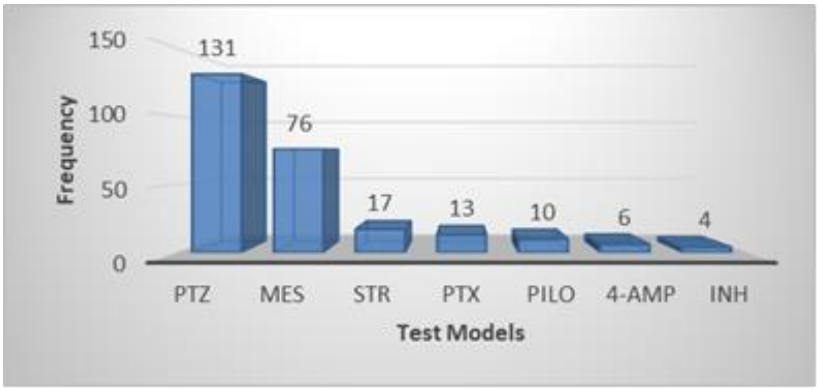

Figure 3: Some models used in the antiepileptic assays. *MES = Maximal electroshock; PTZ = pentylenetetrazole;* 4-AMP = 4-aminopyridine; INH = *Isoniazid*; PILO = pilocarpine; PTX = picrotoxin; STR = Strychnine;

V. Conclusion

The results from this study confirm that plant exhibit antiepileptic properties that needs to be explored for antiepileptic formulation and drugs development. It is also necessary to perform bioassay guided phytochemical evaluation to isolate and characterize the antiepileptic principles.

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